Accuracy Characteristics for ZDV Risk Reduction Conflict Scenario, Hours 2056-2305

1 Introduction

This document contains an abridged version on the scenario characteristics for hours 2056 to 2305 (actual recorded data from 20:56:00 to 23:05:16) GMT recorded on December 11, 2002 at Denver ARTCC (ZDV). Characteristics provided are general statistics determined from the scenario on general air traffic activity and aircraft and air carrier characteristics. Definitions for these scenario characteristics are provided in [1]. Definitions for the conflict and encounters in Tables 1 and 2 are further explained in [2] and [3].

2 Conflict and Encounter Properties

Table 1: Conflict Parameter Distributions

			Non Time-Shifted	Time Shifted[1]	
		Required Sample Size (2x)	Reference (x)	Conflict Analysis 1	Conflict Analysis 2
	Number of Conflicts	108	32	101	84
Horizontal Separation	0 to 1 nm	14 12.96%	4 12.50%	13 12.87%	6 7.14%
	1 to 2 nm	17 15.74%	5 15.63%	16 15.84%	13 15.48%
	2 to 3 nm	27 25.00%	8 25.00%	25 24.75%	22 26.19%
	3 to 4 nm	34 31.48%	10 31.25%	31 30.69%	28 33.33%
	4 to 5 nm	17 15.74%	5 15.63%	16 15.84%	15 17.86%
Vertical Separation	0 to 400 ft	91 84.26%	27 84.38%	84 83.17%	67 79.76%
	400 to 800 ft	10 9.26%	3 9.38%	10 9.90%	10 11.90%
	800 to 1200 ft	3 2.78%	1 3.13%	3 2.97%	3 3.57%
	1200 to 1600 ft	3 2.78%	1 3.13%	3 2.97%	3 3.57%
	1600 to 2000 ft	0 0.00%	0 0.00%	1 0.99%	1 1.19%
Encounter Angle	0º to 30º	47 43.52%	14 43.75%	47 46.53%	38 45.24%
	30º to 60º	20 18.52%	6 18.75%	19 18.81%	15 17.86%
	60º to 90º	10 9.26%	3 9.38%	10 9.90%	7 8.33%
	90º to 120º	3 2.78%	1 3.13%	3 2.97%	3 3.57%
	120º to 150º	14 12.96%	4 12.50%	11 10.89%	11 13.10%
	150º to 180º	14 12.96%	4 12.50%	11 10.89%	10 11.90%
Phase of Flight	Level-Level	54 50.00%	16 50.00%	50 49.50%	43 51.19%
	Level-Trans	41 37.96%	12 37.50%	38 37.62%	32 38.10%
	Trans-Trans	14 12.96%	4 12.50%	13 12.87%	9 10.71%

[1] Conflict Analysis 1 includes analysis on the Conflict Scenario evaluated based on aircraft tracks starting at the inbound handoff and ending at center crossing boundary (same as Reference Scenario). Conflict Analysis 2 includes the same Conflict Scenario evaluated based on aircraft tracks starting at the first HCS recorded track report and ending at outbound handoff (this is same rules used in URET CCLD Formal Accuracy Test).

Table 2: Encounter Parameter Distributions

		Non Time-Shifted	Time Shifted[2]	
		Reference	Encounter Analysis 1	Encounter Analysis 2
	Number of Encounters	1465	1676	1522
Horizontal Separation	0 to 5 nm	281 19.18%	343 20.47%	298 19.58%
	5 to 10 nm	244 16.66%	284 16.95%	258 16.95%
	10 to 15 nm	337 23.00%	334 19.93%	291 19.12%
	15 to 20 nm	298 20.34%	346 20.64%	321 21.09%
	20 to 25 nm	305 20.82%	369 22.02%	354 23.26%
Vertical Separation	0 to 1000 ft	334 22.80%	452 26.97%	428 28.12%
	1000 to 2000 ft	55 3.75%	88 5.25%	78 5.12%
	2000 to 3000 ft	859 58.63%	883 52.68%	782 51.38%
	3000 to 4000 ft	43 2.94%	54 3.22%	44 2.89%
	4000 to 5000 ft	174 11.88%	199 11.87%	190 12.48%
Encounter Angle	0º to 30º	244 16.66%	314 18.74%	294 19.32%
	30º to 60º	140 9.56%	178 10.62%	169 11.10%
	60º to 90º	54 3.69%	80 4.77%	77 5.06%
	90º to 120º	64 4.37%	55 3.28%	53 3.48%
	120º to 150º	208 14.20%	234 13.96%	207 13.60%
	150º to 180º	755 51.54%	815 48.63%	722 47.44%
Phase of Flight	Level-Level	1032 70.44%	1043 62.23%	933 61.30%
	Level-Trans	303 20.68%	447 26.67%	430 28.25%
	Trans-Trans	130 8.87%	186 11.10%	159 10.45%

[2] Same as footnote 1 for encounter analysis. Note: time shifting methodology targeted generation of twice the Reference Scenario's conflict distribution, but the distribution of encounters are achieved only as a consequence.

3 Air Traffic Distributions

This section provides metrics that characterize the air traffic. The metrics are flight density partitioned by standard flight levels, flight type and sector penetration, statistics on the number of active flights, ground speed statistics, counts of interim altitude and amendment messages, and air traffic maneuvers by altitude and phase of flight. This section corresponds to Section 3.3 of Reference[1].

3.1 Active Flights

This section corresponds to section 3.3.2 of Reference[1].

Table 1: Statistics on Active Flights per Minute Increment

Count Average	Standard Deviation	Maximum Count	Minimum Count
157.3953	99.1957	281	0

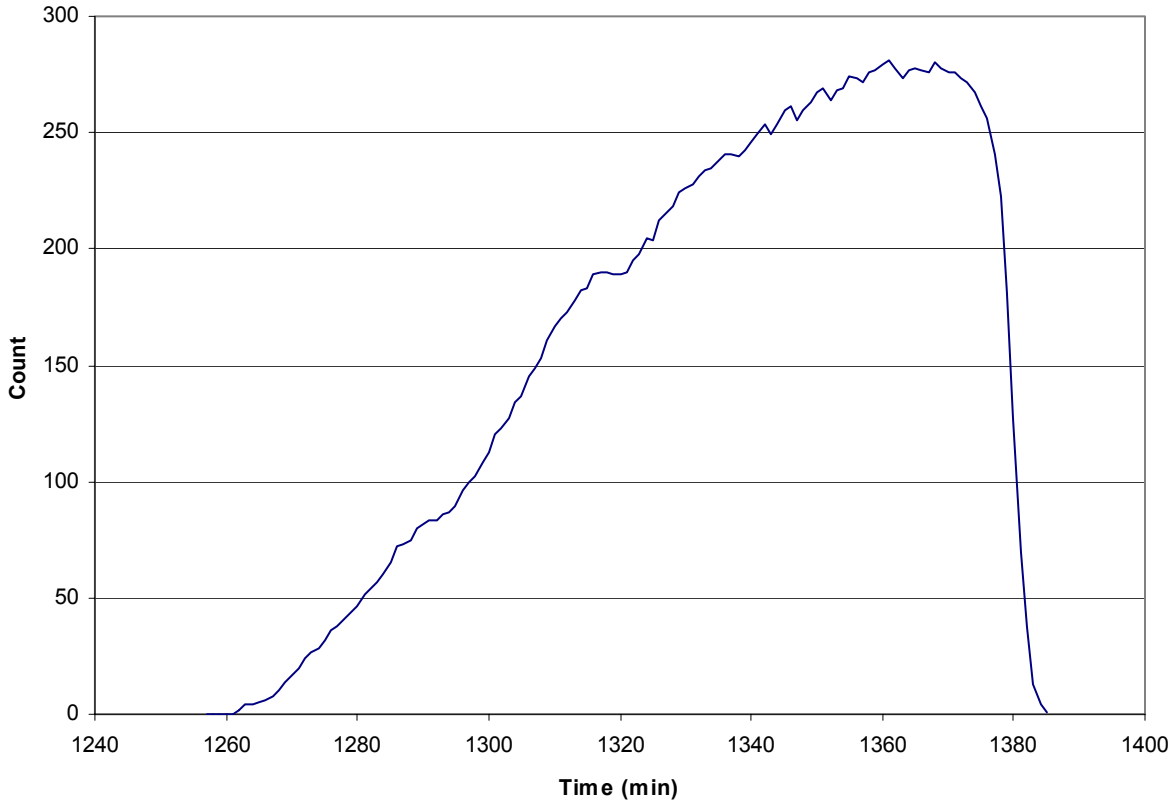

Figure 1: Count of Active Flights per Minute Increment

3.2 Flight Type and Sector Penetration

This section corresponds to Section 3.3.3 of Reference[1].

Table 2: Statistics on Sector Time, Center Time and Sector Penetration by Flight Type

Metric	Arrivals	Departures	Internals	Overflights	All Flights
Average Number of Sectors Penetrated	2.461	2.536	2.045	2.958	2.669
Average Time in Center (sec)	1622.549	1501.786	1544.545	1948.277	1729.848
Average Time in Sector (sec)	653.386	587.493	732.556	652.486	641.285
Percentage by Flight Type	19.300	26.500	8.300	45.100	100.000

3.3 Interim Altitude Messages

This section corresponds to Section 3.3.6 of Reference[1].

Table 3: Statistics on Interim Altitude Messages [3]

Flight Count	Average	Standard Deviation	Maximum Count	Minimum Count
294	2.602	0.917	6	1

3.4 Amendment Messages

This section corresponds to Section 3.3.7 of Reference[1]

Table 4: Statistics on Amendment Messages per Flight[4]

Flight Count	Average	Standard Deviation	Maximum Count	Minimum Count
208	2.168	1.190	8	1

[3] Statistics on flights with interim altitude messages only
[4] Statistics on flights with flight plan amendments only

3.5 Air Traffic Maneuvers

This section corresponds to Section 3.3.8 of Reference[1]. Detailed statistics on air traffic maneuvers are provided in Appendix C.

Table 5: Total Track Report Maneuver Count by Vertical and Horizontal Phase of Flight

Vertical Phase	Horizontal Phase of Flight		Total
	STR	TURN	
ASC	2208	366	2574
DES	2207	371	2578
LEV	999	525	1524
Total	5414	1262	6676

Table 6: Percent breakdown of Flight Tracks by Vertical and Horizontal Phase

Vertical Phase	Horizontal Phase of Flight		Margin (%)
	STR (%)	TURN (%)	
ASC	33.074	5.482	38.556
DES	33.059	5.557	38.616
LEV	14.964	7.864	22.828
Margin (%)	81.096	18.904	100.000

4 Aircraft Distributions

This sections provides the metrics used to characterize the aircraft provided in the scenario. The selected metrics are aircraft type, model, navigational equipment, and the air carriers operating in the airspace. The section corresponds to Section 3.4 of Reference[1].

4.1 Aircraft Type

This section corresponds to Section 3.4.1 of Reference[1].

Table 7: Count by Aircraft Type

Aircraft Type	Count	Percentage of Total
J	427	81.489
T	10	1.908
P	72	13.740
Unknown	15	2.863
Total	524	100.000

4.2 Aircraft Models

This section corresponds to Section 3.4.2 of Reference[1].

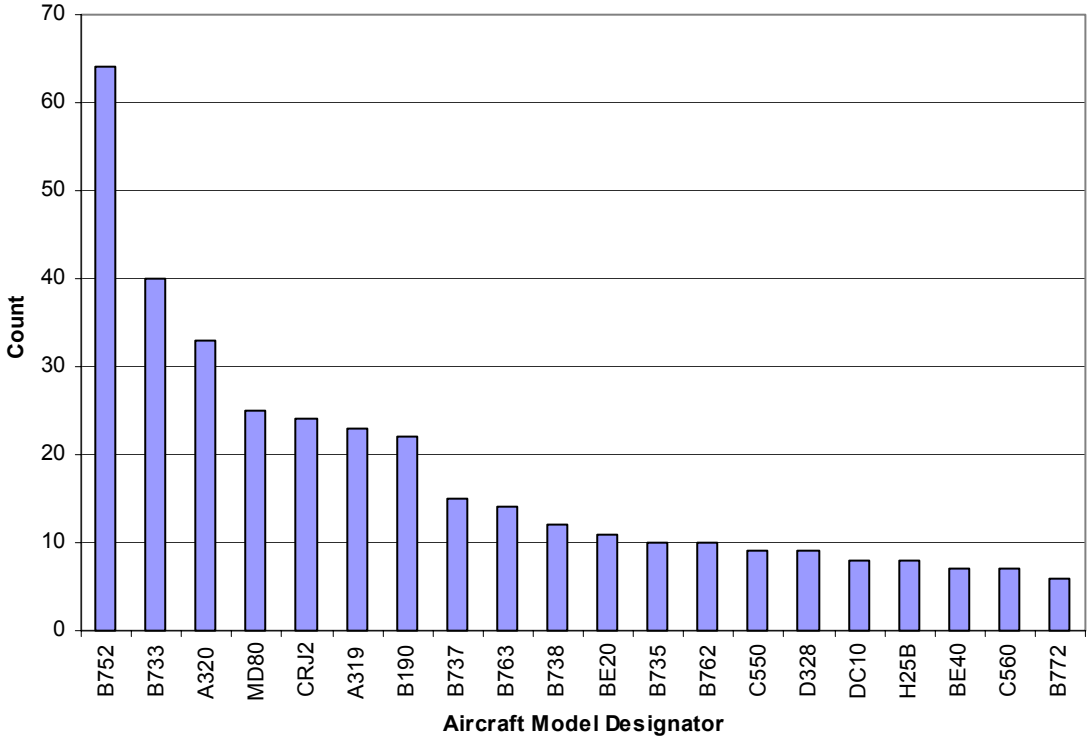

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Figure 2: Count of Top Twenty Aircraft Models

4.3 Navigational Equipage

This section corresponds to Section 3.4.3 of Reference[1].

Table 8: Count by Aircraft Navigational Equipage Type

Nav. Equip. Designator	Count	Percentage of total
E	159	30.114
G	99	18.750
F	94	17.803
R	57	10.795
A	51	9.659
I	49	9.280
Q	8	1.515
W	7	1.326
Unknown	4	0.758
Total	528	100.000

4.4 Carrier Distribution

This section corresponds to Section 3.4.4 of Reference[1].

Table 9: Count by Carrier Type

Category	Count	Percentage of Total
Commercial	407	77.083
General Aviation	100	18.939
Other[5]	21	3.977
Total	528	100.000

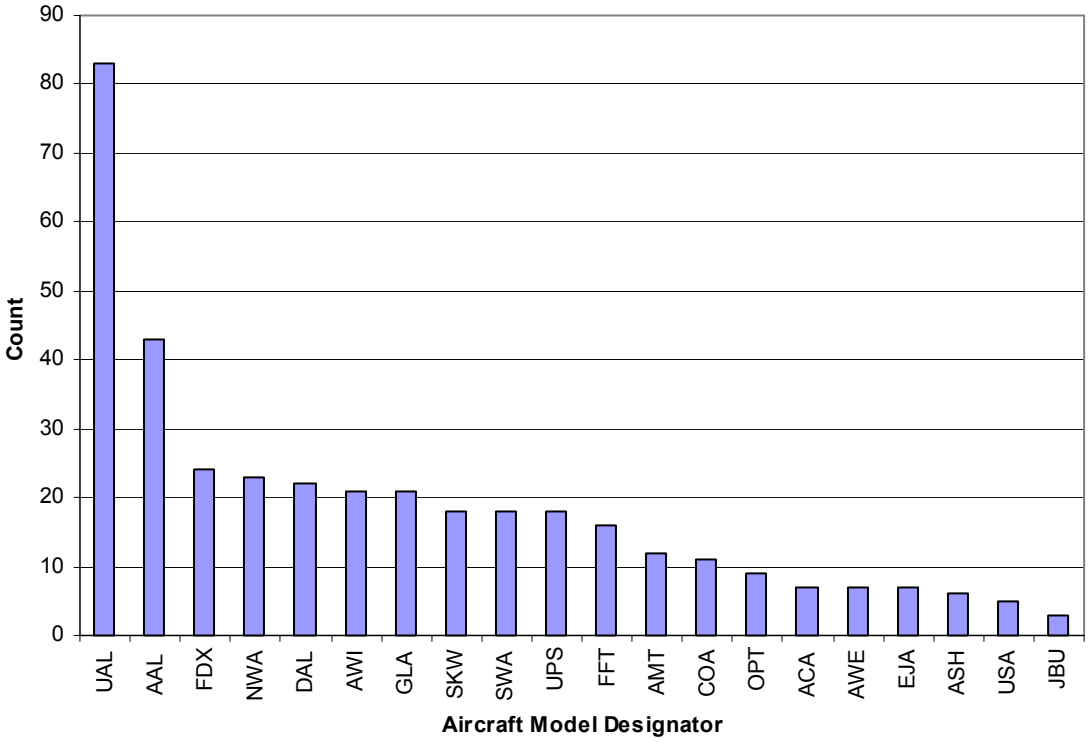

Figure 3: Count by Top Twenty Air Carriers

[5] Includes military and aircraft with unrecognized designators

5 References

[1] Paglione, M., Oaks, R., Ryan, Dr. H., Summerill, J.S., (Final, January 2000), "Description of Accuracy Scenarios for the Acceptance Testing of the User Request Evaluation Tool (URET) / Core Capability Limited Deployment (CCLD)," FAA William J. Hughes Technical Center / ACT-250, Atlantic City, New Jersey.

[2] Paglione, Mike M., Oaks, Robert D., Summerill, J. Scott, "Time Shifting Air Traffic Data for Quantitative Evalution of a Conflict Probe," Submitted to the *American Institute of Aeronautics and Astronautics (AIAA) Guidance, Navigation, and Control Conference*, Austin TX, August 2003.

[3] Paglione, Mike M., Oaks, Robert D., Bilimoria, Karl D., "Methodology for Generating Conflict Scenarios by Time Shifting Recorded Traffic Data," Submitted to 5th *USA/EUROPR Air Traffic Management R&D Seminar*, Budapest, Hungary, June 2003.

6 Appendix

At the special request of Lockheed Martin, listed below are encounter counts delineated into the URET Accuracy Specification bins. Conflict counts are listed in Table 1, Section 2 above.

Table A.10: URET Formal Req'd Current Plan Conflict/Encounters[6]

Min. Horz. Separation (nm)	Without Adherence	13 Minutes Adherence
$0 \leq d < 5$	214	179
$5 \leq d < 10$	258	206
$10 \leq d < 15$	291	232
$15 \leq d < 23$	528	398
$23 \leq d < 30$	469	363
Total	1760	1378

Table A.11: URET Formal Req'd Trial Plan Conflict/Encounters[7]

Min. Horz. Separation (nm)	Without Adherence	20 minutes Adherence
$0 \leq d < 5$	214	176
$5 \leq d < 10$	258	201
$10 \leq d < 15$	291	228
$15 \leq d < 24$	606	454
$24 \leq d < 30$	391	293
Total	1760	1352

[6] This table contains encounters only. These are not violations of standard separation, but aircraft-to-aircraft separations at larger values or situations where legal separation has not been violated in both vertical and horizontal dimensions simultaneously.

[7] This table contains encounters only, see previous footnote.